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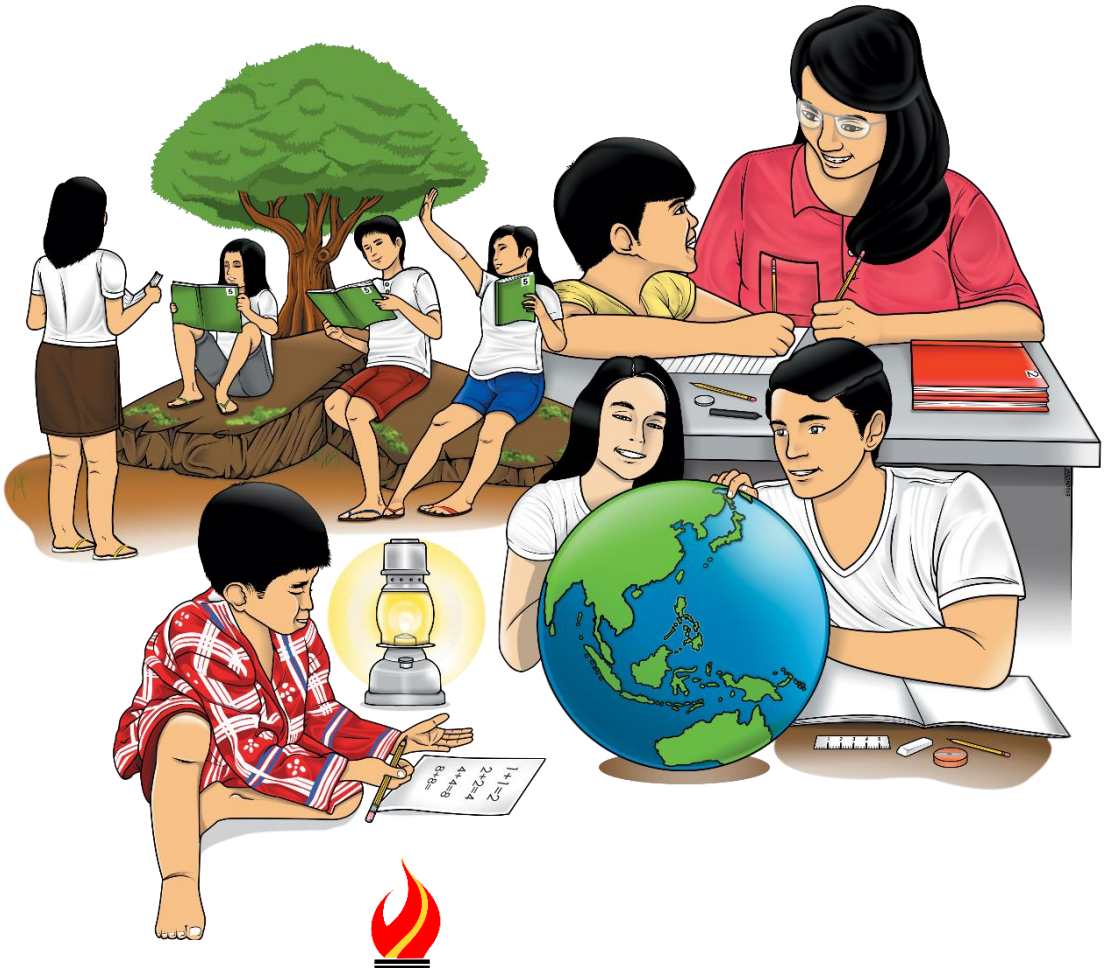
Science

Quarter 4 – Module 1.3:
Kinetic Molecular Theory



ALTERNATIVE DELIVERY MODE
ADM

Science – Grade 10
Alternative Delivery Mode
Quarter 4 – Module 1.3: Kinetic Molecular Theory
First Edition, 2020

Published by the Department of Education
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Undersecretary: Diosdado M. San Antonio

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Printed in the Philippines_____

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Quarter 4 – Module 1.3:
Kinetic Molecular Theory

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

It is fascinating to see the clouds and the balloon up in the sky, isn't it? What do you think makes the balloon stay up there? Do you know what is inside the balloon? Look at the clouds. They also stay up in the sky like the balloon. What do they have in common?

Different kinds of materials behave differently. Among the three states of matter, gases seem to be the most difficult to understand because their physical attributes are not readily seen.

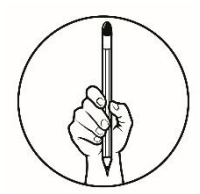
In this module, you will understand the properties of gases that distinguish them from solids and liquids based on the Kinetic Molecular Theory.

After going through this module, you should be able to:

1. demonstrate understanding of the behavior of gases; and
2. explain the relationships of the properties of gases using the Kinetic Molecular Theory (**S10MT-IVa-b-21**).

Going through this module can be a meaningful learning experience. All you need to do is make use of your time and resources efficiently. To do this, here are some tips for you:

1. Take the pretest before reading the rest of the module.
2. Take time in reading and understanding the lesson. Follow instructions carefully. Do all activities diligently. This module is designed for independent or self-paced study. It is better to be slow but sure than to hurry and miss the concepts you are supposed to learn.
3. Use a separate sheet of paper for your answers in each activity or assessment. Don't forget to write your name. Label it properly.
4. Try to recall and connect the ideas about gases that you had in the lower years. Use the concept discussed in the lesson to explain the results of activities or performance task. You may answer in English or a combination of your vernacular and English.
5. Be honest. When doing the activities, record only what you have really observed. Take the self-assessments after each activity, but do not turn to the Answer Key page unless you are done with the entire module.
6. Don't hesitate to ask. If you need to clarify something, approach or contact your teacher or any knowledgeable person available to help you. You may also look into other references for further information. There is a list of reference at the back part of this module.
7. Take the posttest prepared at the end of the module, so you can assess how much you have learned from this module.
8. You can check your answers in the activities, self-assessments, and posttest after you finished the entire module to know how much you have gained from the lesson and the activities.



What I Know

Directions: Read carefully each item. Write only the letter of the correct answer for each question. Use a separate sheet of paper for your answers.

1. Which of the following is not a fundamental assumption of the kinetic molecular theory?

   a. Gas particles are in a constant state of random motion and move in straight lines until they collide with another body.
   b. Since the collisions of molecules are perfectly elastic, there is a strong attractive force between molecules in the gaseous state.
   c. Collisions between gas particles are completely elastic. In other words, there is no net loss or gain of kinetic energy when particles collide.
   d. The temperature of gas is proportional to the average kinetic energy of the molecules.

2. Which of the following causes gas pressure?

   a. gas molecules heating up
   b. gas molecules knocking other gas molecules
   c. gas molecules hitting the walls of a container
   d. gas molecules bonding with other gas molecules

3. Which of the following properties does not describe a gas?

   a. malleability
   b. pressure
   c. temperature
   d. volume

4. Which of the following has particles that can be drawn closer to occupy smaller volume?

   a. air inside the syringe
   b. firewood
   c. fruit juice
   d. ice cube

5. Which of the following does not involve the application of gas pressure?

   a. burning fuel
   b. falling leaves
   c. rising hot air balloons
   d. vulcanizing tire

6. Which of the following statements is not in harmony with the kinetic-molecular theory of gases?

   a. Individual gas molecules are relatively far apart.
   b. The actual volume of the gas molecules themselves is very small compared to the volume occupied by the gas at ordinary temperatures and pressures.
   c. The average kinetic energies of different gases are different at the same temperature.
   d. There is no net gain or loss of the total kinetic (translational) energy in collisions between gas molecules.

7. Which of the following statements is false?

   a. The density of a gas is constant as long as its temperature remains constant.
   b. Gases can be expanded without limit.
   c. Two or more gases can mix quickly and easily with one another to form a homogeneous mixture.
   d. The molecular weight of a gaseous compound is a non-variable quantity.

8. Which of the following statements does not agree with the kinetic molecular theory of gas?

   a. Gas particles are in constant motion.
   b. Gas particles are spaced far apart from each other.
   c. Gas particles move in predictable patterns.
   d. Gas particles move independently of one another.

9. What is the average kinetic energy of the particles in a substance?

   a. equal to the total thermal energy absorbed by the substance
   b. increased as the temperature of the substance decreases
   c. increased as the temperature of the substance increases
   d. unaffected by changes in the temperature if the substance increases

10. What happens to the kinetic energy of the particles in a sample of gas as the temperature of the sample increases?

   a. It decreases.
   b. It increases.
   c. It increases, then decreases.
   d. It does not change.

11. Which of the following is not a characteristic of liquids?

a. Liquids conform to the shape of their container.
b. Liquids have the ability to flow.
c. The particles of liquids are closer together than particles of gases.
d. The particles of a liquids are not attracted to each other.

12. Which of the following characteristics is true of most solids?

a. Solids are viscous.
b. Solids are incompressible.
c. Solids generally expand easily.
d. Solids are made up of particles in constant motion.

13. Why is it possible for equal volumes of gases, at standard pressure and temperature, to contain equal numbers of particles?

a. Gas particles are spaced far apart.
b. Gas particles are large in size.
c. The volume of a gas is inversely proportional to its mass.
d. This is not possible.

14. What will happen to the liquid when the atmospheric pressure is equal to the vapor pressure?

a. boil
b. condense
c. melt
d. solidify

15. Which of the following will you vary to make water boil at 75 ºC, instead of 100 ºC?

a. Add more heat.
b. Decrease the volume of water you are boiling.
c. Increase air pressure.
d. Heat the water at higher altitude.

Answer Key on page 22

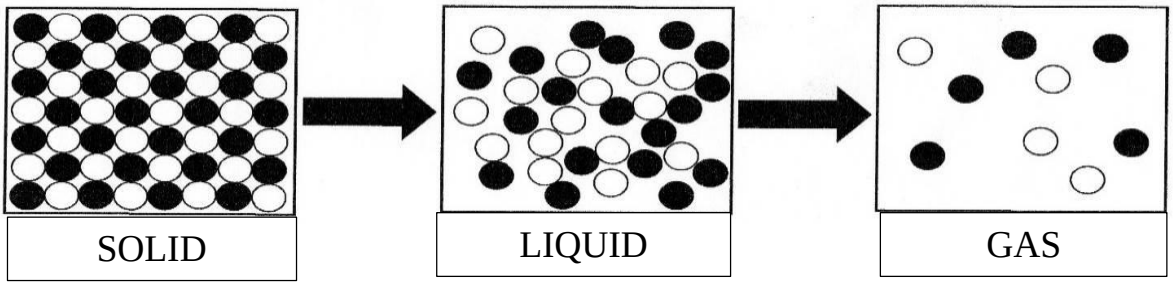
How did you find the pretest? What was your score? If you got 15 items correctly, you may skip the module. But if your score is 14 and below, you must proceed with the module.

Lesson 1 Kinetic Molecular Theory

Matter can have different properties, and all matters have mass and volume. Properties of matter such as hardness, texture, color, flexibility, malleability, and electrical conductivity which vary from one sample to another can be easily studied for solids and liquids but not for gases. To continue visualizing what matter is made of, particularly gases, this section will try to explain the behavior of very small 'particles' beyond what your eyes can see.

What's In

A. In Grade 9 you have a better picture or view of how the particles are arranged in the three states of matter: solid, liquid, and gas. Study the models below, then identify the phase being described. Write your answers on a separate sheet of paper.



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SDO-San Carlos City, Pangasinan

_____1. Particles are very close to each other and move in a fixed position.

_____2. Particles are far apart and move freely.

_____3. Particles are able to vibrate about their fixed position. Thus, attractions between them are very strong.

_____4. The random motion of the particles and their freedom to slide against each other result in weaker forces of attraction. It assumes the shape of the containers. However, the volume is definite.

_____5. Particles have very weak forces of attraction between them and account for their unique properties.

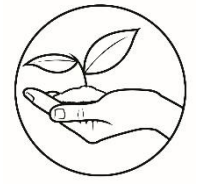
B. Complete the table below using the following list of phrases provided below:

Difficult to compress	*Fixed volume*	*Rapid diffusion*
Same volume as container	*Fixed shape*	*Very low density*
Very high density	*Takes the shape of the*	
No diffusion.	*Easily compressed*	

Property	Solid	Liquid	Gas
Shape		Takes the shape of the container	
Density		Quite high density	
Volume		Fixed volume	
Diffusion		Slow	
Ease of Compression		Slightly compressible	

When we talk about gases, they have no definite shape and size, while mass and volume are not directly measurable. The kinetic theory of gases is useful and can be applied in this case. Kinetic theory of gases explains the three macroscopic properties of a gas in terms of the microscopic nature of atoms and molecules making up the gas. Usually, physical properties of solids and liquids can be described by their, size, shape, mass, volume etc.

In your previous lessons, you have taken into account three properties of gases, namely, pressure, volume and temperature. These properties along with the kinetic molecular theory of gases will play a significant role in helping you understand the physical properties of gases at the molecular level.



What's New

What Can Gases Do?

This activity aims to help you observe accurately the qualitative properties of gases. Be sure to explain your observations.

What you need:

plastic bag	2 soft drink plastic straws
string	2 pieces paper bags (same size)
pin	2 pieces thread (each 25 cm long)
match	perfume or cologne
candle	

Part A.

What you have to do:

1. Blow air into a plastic bag and tie the open end.
2. Squeeze and press it gently.
3. Observe what happens.

Figure 1. Plastic bag with air

Illustrator: Toribio L. Erestingcol II
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These students did the same activity described above.

Question 1: Which two students describe what they observed?

- Lito: The plastic bag is filled with air.
- Mario: The plastic bag becomes smaller when squeezed.
- Ana: The plastic bag burst when pressed gently.
- Susan: The air particles inside become smaller when the plastic bag was squeezed.

Answer: _____

Part B.

What you have to do:

1. Fill your mouth with air. Press your cheeks with your fingers.
2. Answer the following questions:
   a. Did air occupy space in your mouth?

      _____

   b. Were you able to press your cheeks with your fingers? Why?

      _____

      _____

   c. When you pressed one of your cheeks, did you feel the air moving to the other side of your cheek? Explain what happened.

      _____

      _____

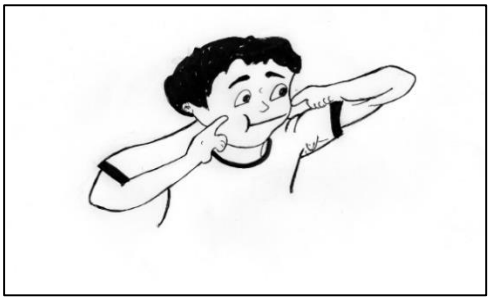

Figure 2. Pressing the cheeks
Illustrator: Toribio L. Erestingcol II
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These students did the same activity described above.

Question 2: Which two students have made INCORRECT statements?

- Lito: Air can be squeezed or compressed.
- Mario: Air particles can be made to fill smaller space.
- Ana: Air particles become smaller when pressed.
- Susan: Air particles decrease in number when pressed.

Answer: _____

Part C

What you have to do:

1. Open the small paper bags. Turn them upside down. To the center of the bottom, attach a thread about 25 cm long with a piece of tape.
2. Hang the two bags upside down, one on each end of the plastic straw. Balance this on a pin attached to the other plastic straw. (See figure 3)

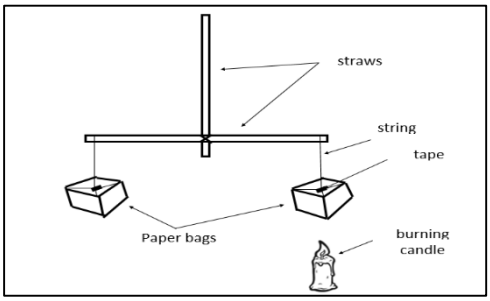

Figure 3. Paper bag set-up
Illustrator: Toribio L. Erestingcol II
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Note: Make sure that the straws move freely around the pin.

BE CAREFUL NOT TO SET THE BAG ON FIRE.

3. Let your companion hold the upright straw. Light a candle and hold it upright about 5 cm away underneath one bag.
4. Take the lighted candle away from the first bag. Hold it underneath the other bag.

These students were asked to comment on the activity described above.

Question 3: With whom do you agree?

- Lito: Air particles move into smaller space when heated and become heavier.
- Mario: Air inside the bag expands when heated, thus pushes the bag up.
- Ana: When air is cooled, it becomes heavier.
- Susan: Air particles become lighter when cooled.

Answer: _____

Part D

What you have to do:

1. Spray a very small amount of perfume or cologne into the air.
2. Answer the following questions:
   a. Can you see the particles of perfume or cologne?

      _____

   b. How did it reach your nose?

      _____

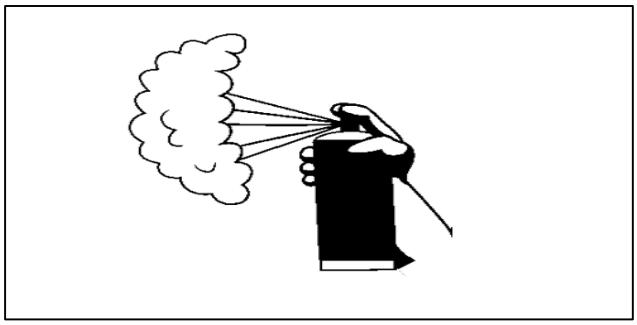

Figure 4. Perfume spray

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These students did the same activity described above.

Question 4: Which two students made **incorrect** interpretations?

- Lito: Gas particles move in all directions.
- Mario: Gas particles can spread out in one direction and fill up only a limited space.
- Ana: Gas particles are held together to forces which prevent them from moving.

- Susan: Gases are made up of tiny particles which move around all the time.

Answer: _____

The following generalizations can be inferred from the four activities:

- Gases can be compressed; hence they can occupy a small space.
- Gas particles can spread in any direction.
- Gases are made up of tiny particles that are always moving.
- When gas particles get hot, they move and spread faster. Thus, they occupy a larger space.

What is It

Did you see the connection of kinetic molecular theory in the previous activity? What state of matter is involved in all of the three situations above? These situations involved gases. All of the properties and characteristics of gases can be described using the kinetic molecular theory.

The Kinetic Molecular Theory (KMT) effectively explains the behavior of gases. As a product of numerous experiments and years of investigations by several scientists, the theory closely conforms to reality.

The Kinetic Molecular Theory (KMT) consists of several postulates.

A. A gas is composed of large number of particles, either atoms or molecules. They are so small compared to the distance separating them that their own size can be considered negligible. Compared to the total gas volume, the particles occupy negligible volume. A considerable empty space exists between particles.

B. Gas particles move randomly in straight line motion and collide with each other and the container frequently. The force of collisions of the gas particles with the walls of the container causes pressure.

C. Collisions of gas molecules are perfectly elastic. This means no energy is lost as friction when molecules collide.

D. Gas particles exhibit almost negligible attractions and repulsions for each other. The molecules thus, move freely as far as space will allow.

E. The average kinetic energy of gas molecules is directly proportional to the absolute temperature (Kelvin). At the same temperature, the molecules of all gases will have the same average kinetic energy.

What's More

Have you ever asked yourself why you can smell the aroma of brewed coffee, the trace of burnt food, the sour scent of lemons, the stench of trash bin and the fragrance of perfume? These few examples indicate that the molecules of matter move.

The activity will help you observe accurately the qualitative properties of gases. Be sure to explain your observations.

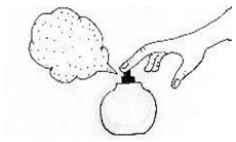
Activity 1. Getting to Know Gases

What you need:

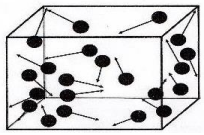
- ✓ separate sheet of paper
- ✓ ball pen

What you have to do:

Match the drawing with the correct property of gas. Use a separate sheet of paper for your answers.

_____1. 

_____2. 

_____3. 

_____4. 

_____5. 

a. Gases have no definite shape or volume. A gas's volume refers to the space of the container in which its molecules have range to move.

b. Gases are highly compressible when pressure is applied.

c. Gases expand when heated and contract when cooled.

d. Gases have lower density than other states of matter, such as solids and liquids.

e. Gas particles move randomly and spread everywhere, even in spaces where other gases are already present. The spreading out of particles is known as diffusion.

f. Gas molecules collide with one another and with the walls of the container.

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Assessment 1

Directions: Mark a (✓) if the statement is correct and (✗) if incorrect. Write your answers on a separate sheet of paper.

_____1. Gases exert pressure.
_____2. Gas is a state of matter that has no fixed shape and no fixed volume.
_____3. Smoke and hot gases tend to go downwards.
_____4. Gases expand when heated and contract when cooled.
_____5. The densities of gases are relatively high compared to the densities of solids and liquids.
_____6. The force of intermolecular attraction between gas particles is negligible.
_____7. There is no limit to the amount of air that can be pumped into a bicycle tire.
_____8. Gases mix evenly and completely when contained in the same vessel.
_____9. Gases are difficult to compress when pressure is applied.
_____10. Cold air tends to go upwards.

Gases behave differently from one another. However, they also manifest common properties. The following are the general properties of gases:

1. All the noble gases (group 18) are monatomic gases, whereas the other gaseous elements are diatomic molecules. Example of these gases are oxygen (O_2), iodine (I_2), chlorine (Cl_2), nitrogen (N_2), and hydrogen (H_2).
2. The volume or space occupied by the molecules themselves is negligible as compared to the total volume of the container so that the volume of the container can be taken as the volume of the gas.
3. Gases are easily compressed when pressure is applied.
4. Gases expand when heated and contract when cooled.
5. Gases exert pressure in all directions on the walls of their container.
6. Gases have lower densities than solids and liquids.
7. The attractive forces between molecules (intermolecular) are negligible.
8. Gases mix evenly and completely when contained in the same vessel.

Activity 2. Better Insight on Kinetic Molecular Theory

What you need:

- ✓ separate sheet of paper
- ✓ ball pen

What you have to do:

1. Identify the property of gases that is described by the following observations and write the part of kinetic molecular theory that explains the observation. Use a separate sheet of paper for your answers.

Observation	Property (supply the missing letters)	Kinetic Molecular Theory (choose from Postulate A to E)
1. You smell the food being cooked by your mother.	_ I _ _ U _ I O _	
2. Basketball players know the right "feel" of the ball.	P _ E _ S _ _ E	
3. A dough of *pandesal* increases in size when placed in an oven.	E _ _ A _ S _ O N	

2. Below are the postulates of the KMT. Identify the KMT postulate that describes each characteristic of gas particles found in the Table. Write the letter of the correct answer on a separate sheet of paper.

Postulates of the Kinetic Molecular Theory (KMT)

a. A gas is composed of large number of particles, either atoms or molecules. They are so small compared to the distance separating them that their own size can be considered negligible. Compared to the total gas volume, the particles occupy negligible volume. A considerable empty space exists between particles.
b. Gas particles move randomly in straight line motion and collide with each other and the container frequently. The force of collisions of the gas particles with the walls of the container causes pressure.
c. Collisions of gas molecules are perfectly elastic. This means no energy is lost as friction when molecules collide.
d. Gas particles exhibit almost negligible attractions and repulsions for each other. The molecules thus, move freely as far as space will allow.
e. The average kinetic energy of gas molecules is directly proportional to the absolute temperature (Kelvin). At the same temperature, the molecules of all gases will have the same average kinetic energy.

Characteristic of Gas Particles	KMT Postulate
1. Size	
2. Attractions	
3. Motion	
4. Collisions	
5. Energy	

Assessment 2

Directions: Kinetic Molecular Theory can explain the properties of gases. Match the property with the possible explanation. Write the letter of the correct answer on a separate sheet of paper.

	Property	**Explanation**
_____	1. Gases have no definite shape. The volume of a gas is equal to the volume of the container confining it.	a. Because the molecules are so small and far apart, they can easily be pushed together.
_____	2. Gases have a very low density.	b. Since the rapidly moving molecules are far apart, there is an ample room for moving.
_____	3. Gases have a very high compressibility.	c. The particles are moving rapidly in all directions. There is very little force of attraction between the molecules. They can move freely to fill the containers.
_____	4. Gases exert pressure equally in all directions on the walls of their container.	d. The molecules are moving rapidly in all directions. They collide with each other and on the sides of the container. Pressure is a result of these collisions.
_____	5. Gases mix thoroughly and spontaneously with one another. Gases easily diffuse.	e. Particles are widely separated, so there are relatively few of them in a given volume.

Activity 3. Examining Kinetic Molecular Theory

What you need:

- ✓ separate sheet of paper
- ✓ ball pen

What you have to do:

Use the kinetic molecular theory to explain what happens at the particle level in each of the situations below. Write your answer on a separate sheet of paper.

1. An inflated balloon is placed in the refrigerator. When it is removed an hour later, it has shrunk to about half of its original size.
   Explain:
   _____

2. A woman places several moth balls in a ziplock bag and seals the bag. Several days later, she notices that the bag has become inflated and the moth balls are much smaller.
   Explain:
   _____

3. An aerosol can is inadvertently placed on a kitchen counter very near the stove. A stove burner is turned and several minutes later the aerosol container explode.
   Explain:
   _____

Assessment 3.

Directions: Read carefully each item. Write only the letter of the correct answer for each question. Use a separate sheet of paper for your answers.

1. Air freshener and toilet deodorant give a fresh scent to a room. The freshness is due to:
   a. the cleanliness of the room after spraying
   b. the diffusion of the odor vapors of the air freshener or toilet deodorant
   c. the removal of stale air after spraying
   d. all of the above

2. Which of the following observations **does not** involve particle motion?
   a. Cigarette smoke reaches you even when you are far from the smoker.
   b. Spices, such as pepper and ginger, give food a strong taste.
   c. Garbage thrown into a river makes the river unfit for swimming and aquatic growth.
   d. Radiation from the Chernobyl nuclear accident was never detected in the atmosphere of the neighboring countries of the USSR.

3. Which of the following explains why the smell of skunk spray can seep into a house even when the windows are closed?
   a. All particles are infinitely small, and the size of a particle is negligible compared to the container that it holds.
   b. The mean kinetic energy of the particles is directly proportional to absolute temperature.
   c. The particles of gas are in constant motion and move randomly in straight lines.
   d. The particles of gas do not exert any force of attraction or repulsion on each other. There is no energy loss during a collision.

4. Which postulates of KMT explains why the scent of brewed coffee in the morning fills up every room in the house?
    a. All particles are infinitely small, and the size of a particle is negligible compared to the container that it holds.
    b. The mean kinetic energy of the particles is directly proportional to absolute temperature.
    c. The particles of gas are in constant motion and move in straight lines.
    d. The particles of gas do not exert any force of attraction or repulsion on each other. There is no energy loss during a collision.

5. Which of the following is **true** when air is added into an automobile tire?
    a. The gas density decreases.
    b. The gas molecules move faster.
    c. The gas molecules collide more frequently.
    d. The space between the molecules increases.

What I Have Learned

Great job! You are almost done with this module. Let's summarize what you have learned from the lesson and activities by choosing the correct word inside the parenthesis. Choose and write your answers on a separate sheet of paper.

1. (Pressure, Volume) is defined as the amount of space and object occupies.
2. (Gas, Solid) is viewed as collection of widely separated molecules in chaotic and constant motion.
3. (Gases, Solids) have a very high compressibility.
4. (Solids, Liquids) tend to have a high density.

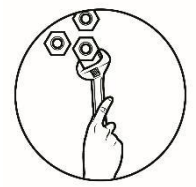
5– 6 Gas particles have (big, little) attraction for one another. Therefore, attractive forces between gas molecules can be (ignored, noticed).

7– 8 The distance between the gas particles is (large, small) compared to their size. Therefore, the volume occupied by gas molecules is (big, small) compared to the volume of the gas container.

9. Gas particles move in (straight, zigzag) lines and collide with each other and the container frequently. The force of collisions of the gas particles with the walls of the container causes pressure.
10. The average (kinetic energy, potential energy) of gas molecules is directly proportional to the absolute temperature.

11-12 Collisions among molecules are perfectly (elastic, inelastic), that is, energy may transfer from molecule to molecule as the result of collision, but the total energy of all the molecules in the system (remains constant, varies).

13-15. The frequency of collision is affected by temperature because gas molecules move (faster, slower) at high temperature. On the other hand, they move slowly at (high, low) temperature. The faster the movement of the molecules, the more frequent the collision causing an increase in (pressure, volume).



What I Can Do

Air pollution is a mix of hazardous substances from both human-made and natural sources.

Vehicle emissions, fuel oils and natural gas to heat homes, gaseous by-products of manufacturing and power generation, particularly coal-fueled power plants, and fumes from chemical production are the primary sources of human-made air pollution. Air pollutants damage the environment and bring hazards to human health.

The problem of air pollution should be addressed before it becomes too late. Cite at least five ways that can be adopted to prevent air pollution.

Rubric

Five or more correct suggestions	5 points
Four correct suggestions	4 points
Three correct suggestions	3 points
Two correct suggestions	2 points
One correct suggestion	1 point
No suggestion	0

Very well done! You are now ready to have your posttest. You may want to go over again the lessons, activities and maps to review for the final assessment. God bless you!

Assessment

Directions: Read carefully each item. Write only the letter of the correct answer for each question. Use a separate sheet of paper for your answers.

1. Which of the following changes to a system **will not** result in an increased pressure?
   a. adding more gas molecules
   b. decreasing the volume of the container
   c. increasing the volume of the container
   d. raising the temperature

2. How do gas molecules move?
   a. constantly and randomly
   b. in a circular motion
   c. in an orderly fashion
   d. in straight-line paths

3. Why do gases differ from solids?
   a. They can be compressed.
   b. They have a definite volume.
   c. They have a higher amount of kinetic energy.
   d. They have collisions with close neighbors.

4. Why are gases similar to liquids?
   a. They are both considered fluids.
   b. They cannot be compressed.
   c. They have a definite volume.
   d. They take the shape of their container.

5. Which of the following is **true** about most gases?
   a. All of the particles are of the same size.
   b. They cannot be compressed.
   c. They expand to completely fill their container.
   d. Their particles are very close together.

6. Which of the following assumptions of the kinetic molecular theory of gases explains that gas molecules after colliding with one another simply bounce off in different directions?

   a. Gases are made up of tiny particles.
   b. Gas molecules move randomly in different directions.
   c. Gas molecules show no attraction for one another.
   d. Gases undergo elastic collisions.

7. Which of the following is the **best** place to store compressed gases?

   a. areas where there is heat;
   b. confined or closed vessel;
   c. corridors or stairways;
   d. secured areas where there is a proper ventilation.

8. At which of the following temperatures will a gas diffuse through a room most rapidly?

   a. 0 °C
   b. 10 °C
   c. 20 °C
   d. 30 °C

9. Last summer vacation, the Cruz family decided to go to Pagudpod, Ilocos Norte to have a beach party. On their way to Ilocos, all of them were surprised when the tire suddenly exploded. What is the probable explanation for the blown-out tire during a long summer drive?

   a. High temperature causes a decrease in volume.
   b. The amount of the gases inside the tire is increased.
   c. The mass of the gases inside the tire increases causing a blown-up tire.
   d. The volume of gases increases as the temperature increases, causing a blown-up tire.

10. Jane can still pump air in the party balloon even though it is already inflated. What explains this phenomenon?

   a. Air molecules can be compressed.
   b. Balloons are made up of plastic.
   c. Balloons look better if their size is bigger.
   d. The air inside the balloon is hot.

11. What is most likely to happen when an aerosol can is heated?

a. The can will be deformed.
b. The can will eventually explode.
c. The can will stay the same.
d. The can will tarnish.

12. Which of the following statements does not agree with the kinetic molecular theory of gases?

a. Gas particles are in constant motion.
b. Gas particles are spaced far apart from each other.
c. Gas particles move in predictable patterns.
d. Gas particles move independently of one another.

13. How does the temperature affect the average kinetic energy of gas molecules?

a. As the temperature decreases, the average kinetic energy of gas molecules decreases.
b. As the temperature decreases, the average kinetic energy of gas molecules increases.
c. As the temperature decreases, the average kinetic energy of gas molecules remains the same.
d. As the temperature decreases, the average kinetic energy of gas molecules fluctuates.

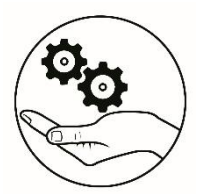
14. Which of the following samples is highly compressible at high pressure and expandable at high temperature?

a. aluminum sheet
b. ice
c. oxygen gas
d. water

15. Which has the greatest kinetic energy?

a. ethyl alcohol (CH_3CH_2OH) vapor at 25 $^{\circ}C$
b. Neon gas (Ne) at 20 $^{\circ}C$
c. Nitrogen gas (N_2) at -50 $^{\circ}C$
d. water (H_2O) at 100 $^{\circ}C$

Congratulations for accomplishing this module! You may now look at the correct answers to all the activities and assessments. The Answer Key is found on page 23.



Additional Activities

Did all the activities give you a better understanding of the properties and behavior of gases based on Kinetic Molecular Theory? Congratulations for a job well done!

Before you return this module to your teacher, kindly copy and fill out the Self-Rating table adapted from Valdoz (2017). Check the appropriate column where your extent of knowledge falls.

How I Rate My Self...

How much did this module help you...	**Poor (1)**	**Fair (2)**	**Good (3)**	**Excellent (4)**
understand properties of gases				
comprehend the assumptions of the Kinetic Molecular Theory?				
explain the properties and behavior of gases based on Kinetic Molecular Theory.				

Answer Key

What I Know

1. b	9. c
2. c	10. b
3. a	11. d
4. a	12. b
5. b	13. a
6. c	14. a
7. a	15. d
8. c	

What's In

A.

1. solid 2. gas 3. solid 4. liquid 5. gas

B

Solid	Gas
Fixed shape	Shape same as container
Very high density	Very low density
Fixed volume	Same volume as container
No diffusion	Rapid diffusion
Almost impossible to compressed	Readily compressed

What's New

Part A

Question1. Ana & Mario

Part B.

2. a. Yes
   b. Yes. Air can be compressed.
   c. Yes. Air particles can be made to fill other space.

Question 2. Susan & Ana

Part C

Question 3. Mario & Ana

Part D.

2. a. No
   b. Gas particles can spread out in all directions.

Question 4. Mario & Ana

What's More

Activity 1.

1. e
2. c
3. f
4. a
5. b

Assessment 1

1. √	6. √
2. √	7. X
3. X	8. √
4. √	9. X
5. X	10. X

What's More

Activity 2

A.

Property	KMT
D I F F U S I O N	A
P R E S S U R E	D
E X P A N S I O N	E

B. 1. c 2. b 3. a 4. d 5. E

Assessment 2

1. c 2. e 3. a 4. d 5. b

Assessment

1. c	6. d	11. b
2. a	7. d	12. c
3. a	8. d	13. a
4. a	9. d	14 c
5. c	10. a	15. d

What I Can Do

1. Use alternative sources of energy such as solar energy and wind energy.
2. Use unleaded gasoline for automobiles.
3. Energy conservation.
4. Better air treatment for industries.
5. Effective waste management,
6. Planting of trees.

What have I Learned

1. Volume	6. Ignored	11. Elastic
2. Gas	7. Large	12. Remains constant
3. Gases	8. Small	13. Faster
4. Solids	9. Straight	14. Low
5. Little	10. Kinetic energy	15. pressure

What's More
Activity 3
Activity 3.

1. The air inside the balloon is a gas, so the particles are moving very fast in random directions and separated by lots of space. They collide frequently with the inside wall of the balloon, which is what keeps the balloon fully inflated. When the balloon is placed in the refrigerator and cooled, the particles of air slow down. They don't collide frequently or as hard with the balloon wall. The balloon wall squeezes the air particles closer together as the balloon shrinks in size.
2. Originally, because the mothballs are solid, the particles are close together and vibrating in fixed positions. The fact that the bag becomes inflated and the mothballs become smaller indicates that part of the mothballs must have become a gas. As a gas, the mothball particles move freely and are separated by a great deal more space, which is why the bag became inflated.
3. Particles of the gas inside the aerosol can are compressed or squeezed very close together. Heat energy from the stove causes these particles to move faster and to exert greater pressure on the inside surface of the can, enough to cause the can to explode.

Assessment 3.

1. b	3. a	5. c
2. d	4. c	

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